

Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

Claim 1 (Currently Amended): A minimally invasive apparatus for harvesting bone marrow cells, blood, and bone fragments, said apparatus comprising:

a rigid cannula having a proximal end and a distal end with an opening, said distal end including a cutting tip that is movable axially and radially to cut and disrupt bone tissue while preserving necessary viability among harvested marrow cells, said cannula further including an inner surface defining an internal passage that extends from said opening toward said proximal end; and

a sheath disposed co-axially about a portion of said cannula for providing and maintaining a single percutaneous puncture site, and

means for applying suction to said internal passage in said cannula for drawing bone marrow cells, blood, and bone fragments disrupted from the bone tissue by said cutting tip into said internal passage for collection.

Claim 2 (Original): The apparatus of claim 1 further comprising control means for controlling said means for applying suction.

Claim 3 (Original): The apparatus of claim 1 further comprising means for controllably supplying irrigation fluid into said internal passage in said cannula.

Claim 4 (Original): The apparatus of claim 3 wherein said means for controllably supplying irrigation fluid is operatively coupled to control means for controlling said means for applying suction in order that irrigation fluid flow and suction can be oscillated so as not to coincide.

Claim 5 (Original): The apparatus of claim 1 further comprising means for controllably injecting an anticoagulant fluid into the harvested bone marrow cells, blood, and bone fragments during collection.

Claim 6 (Original): The apparatus of claim 5 wherein said cannula further includes a plurality of nozzles adjacent said distal end for introducing anticoagulant fluid into harvested bone marrow cells, blood, and bone fragments immediately following their harvest.

Claim 7 (Original): The apparatus of claim 1 further comprising a collection chamber in fluid communication with said internal passage for receiving and collecting the harvested bone marrow cells, blood, and bone fragments.

Claim 8 (Cancelled).

Claim 9 (Original): The apparatus of claim 1 further comprising a rotatable shaft disposed co-axially within said internal passage in said cannula, said shaft having a distal end with a cutting bit for cutting and disrupting bone tissue while preserving necessary viability among harvested marrow cells, said cutting bit projecting through said opening in said cannula.

Claim 10 (Original): The apparatus of claim 9 further comprising means for rotating said shaft and said cutting bit.

Claim 11 (Original): The apparatus of claim 10 further comprising control means for controlling said means for rotating said shaft.

Claim 12 (Original): The apparatus of claim 9 wherein said cannula includes a radially extending end wall that closes a portion of said opening at said distal end of said cannula, said end wall having an axially extending passage through which said shaft projects.

Claim 13 (Original): The apparatus of claim 12 wherein said cannula includes a plurality of circumferentially spaced radially extending apertures through which bone marrow cells, blood, and bone fragments disrupted from the bone tissue are aspirated by said means for applying suction.

Claim 14 (Original): The apparatus of claim 1 wherein said cannula includes a plurality of circumferentially spaced radially extending apertures through which bone marrow cells, blood, and bone fragments disrupted from the bone tissue are aspirated by said means for applying suction.

Claim 15 (Original): The apparatus of claim 1 wherein said opening at said distal end of said cannula extends in the radial direction through said inner surface of said cannula.

Claim 16 (Currently Amended): The apparatus of claim 15 wherein said distal end of said cannula includes a plurality of ~~third~~ nozzles adjacent said radial opening for introducing an anticoagulant fluid into harvested bone marrow cells, blood, and bone fragments.

Claim 17 (Original): The apparatus of claim 15 further comprising a rotatable shaft disposed coaxially with said internal passage in said cannula, said shaft having a distal end with a cutting bit for cutting and disrupting bone tissue while preserving necessary viability among harvested marrow cells, said cutting bit being disposed within said radial opening in said cannula.

Claim 18 (Original): The apparatus of claim 17 wherein said cannula includes a radially extending wall that closes off a portion of said internal passage at said distal end of said cannula, said end wall having an axially extending passage through which said shaft projects.

Claim 19 (Original): The apparatus of claim 18 wherein said cannula includes a plurality of circumferentially spaced radially extending apertures through which bone marrow cells, blood, and bone fragments disrupted from the bone tissue are aspirated by said means for applying suction.

Claims 20-36 (Cancelled).

Claim 37 (Currently Amended): A minimally invasive method for harvesting bone marrow cells, blood, and bone fragments, said method comprising the steps of:

- (a) providing a cannula having a proximal end and a distal end with an opening, the distal end including a cutting tip for disrupting bone tissue while preserving necessary viability among harvested marrow cells, the cannula further including an inner surface defining an internal passage that extends from the opening toward the proximal end;
- (b) inserting the distal end of the cannula through a puncture site, through the cortex of a bone, and into the intramedullary canal of the bone;
- (c) supplying irrigation fluid to the distal end of the cannula to minimize thermal or mechanical trauma to the harvested cells and to help carry the harvested bone marrow cells, blood, and bone fragments into the passage;
- ~~(e)~~ (d) applying suction to the internal passage which draws bone marrow cells, blood, and bone fragments disrupted from the cancellous bone into the internal passage for collection;
- ~~(d)~~ (e) manually moving the distal end of the cannula in both axial and radial directions within the intramedullary canal to cut and disrupt the bone tissue;

(e) (f) manually moving the distal end of the cannula to different locations in the cancellous bone and disrupting additional bone tissue with the apparatus remaining in the same puncture site; and

(f) (g) repeating steps ~~(d)~~ and (e) and (f) to further collect bone marrow cells, blood, and bone fragments.

Claim 38 (Cancelled).

Claim 39 (Original): The method of claim 37 further comprising the step of supplying an anticoagulant fluid into the harvested bone marrow cells, blood, and bone fragments to inhibit clot formation.

Claim 40 (Currently Amended): The method of claim 39 further comprising the step of oscillating a ~~the~~ supply of irrigation fluid and the supply of anticoagulant fluid.

Claim 41 (Original): The method of claim 39 further comprising the step of supplying the anticoagulant fluid at a location adjacent the distal end of the cannula.

Claim 42 (Original): The method of claim 37 further comprising the steps of :
providing a collection reservoir for collecting the harvested bone marrow cells, blood, and bone fragments; and
fluidly connecting the internal passage in the cannula with the collection reservoir.

Claim 43 (Currently Amended): The method of claim 37 further comprising the steps of:

providing a sheath that is disposed co-axially about a portion of the cannula;

and

inserting the sheath percutaneously to the cortex of the bone so that the sheath provides and maintains a single percutaneous puncture site for harvesting bone marrow cells, blood, and bone fragments.

Claim 44 (Currently Amended): The method of claim 37 further comprising the steps of:

providing a rotatable shaft disposed co-axially within the internal passage in the cannula, the shaft having a distal end with a cutting bit that projects through the opening in the cannula; and

rotating the shaft and the cutting bit to cut and disrupt bone tissue in the intramedullary canal while preserving necessary viability among harvested marrow cells.

Claim 45 (Original): The method of claim 37 further comprising the step of aspirating bone marrow cells, blood, and bone fragments disrupted from the bone tissue through a plurality of circumferentially spaced radially oriented apertures at the distal end of the cannula.

Claim 46 (Currently Amended): A minimally invasive method for harvesting bone marrow cells, blood, and bone fragments, said method comprising the steps of:

(a) providing an apparatus having a rotatable shaft with a distal end for disrupting bone tissue, the apparatus further including means for rotating the shaft and a cannula encircling the shaft to define an annular passage;

(b) providing a sheath that is disposed co-axially about a portion of the cannula;

(c) inserting the sheath percutaneously to the cortex of the bone so that the sheath provides and maintains a single percutaneous puncture site for harvesting bone marrow cells, blood, and bone fragments.

~~(b)~~ (d) inserting the distal end of the shaft through the a puncture site, through the cortex of a bone, and into the intramedullary canal of the bone;

~~(c)~~ (e) rotating the shaft to cause a ~~the~~ cutting bit to rotate and disrupt the cancellous bone in the intramedullary canal;

~~(d)~~ (f) applying suction to the annular passage which draws bone marrow cells, blood, and bone fragments disrupted from the cancellous bone into the annular passage for collection;

~~(e)~~ (g) manually moving the distal end of the shaft to different locations in the cancellous bone and disrupting additional bone tissue with the apparatus remaining in the same puncture site; and

~~(f)~~ (h) repeating steps ~~(c) and (d)~~ (e) and (f) to further collect bone marrow cells, blood, and bone fragments.

Claim 47 (Original): The method of claim 46 further comprising the step of supplying irrigation fluid to the distal end of the shaft to minimize thermal or mechanical trauma to the harvested cells and to help carry the harvested bone marrow cells, blood, and bone fragments into the passage.

Claim 48 (Original): The method of claim 46 further comprising the step of supplying an anticoagulant fluid into the harvested bone marrow cells, blood, and bone fragments to inhibit clot formation.

Claim 49 (Original): The method of claim 48 further comprising the step of oscillating the supply of irrigation fluid and the supply of anticoagulant fluid.

Claim 50 (Original): The method of claim 48 further comprising the step of supplying the anticoagulant fluid at a location adjacent the distal end of the cannula.

Claim 51 (Original): The method of claim 46 further comprising the steps of:
providing a collection reservoir for collecting the harvested bone marrow cells, blood, and bone fragments; and
fluidly connecting the passage in the cannula with the collection reservoir.

Claim 52 (Cancelled).

Claim 53 (Currently Amended): The method of claim 46 further comprising the steps of:

- (a) manually moving the distal end of the cannula in both axial and radial directions within the intramedullary canal to cut and disrupt the bone tissue;
- (b) manually moving the distal end of the cannula to different locations in the cancellous bone and disrupting additional bone tissue with the apparatus remaining in the same puncture site; and
- (c) repeating steps ~~(d) and (e)~~ (f) and (g) to further collect bone marrow cells, blood, and bone fragments.

Claim 54 (Original): The apparatus of claim 46 further comprising the step of aspirating bone marrow cells, blood, and bone fragments disrupted from the bone tissue through a plurality of circumferentially spaced radially oriented apertures at the distal end of the cannula.

Claim 55 (New): A minimally invasive apparatus for harvesting bone marrow cells, blood, and bone fragments, said apparatus comprising:

a rigid cannula having a proximal end and a distal end with an opening, said distal end including a cutting tip that is movable axially and radially to cut and disrupt bone tissue while preserving necessary viability among harvested marrow cells, said cannula further including an inner surface defining an internal passage that extends from said opening toward said proximal end;

means for applying suction to said internal passage in said cannula for drawing bone marrow cells, blood, and bone fragments disrupted from the bone tissue by said cutting tip into said internal passage for collection;

means for controllably supplying irrigation fluid into said internal passage in said cannula; and

means for controllably injecting an anticoagulant fluid into the harvested bone marrow cells, blood, and bone fragments during collection.

Claim 56 (New) The apparatus of claim 55 further comprising control means for controlling said means for applying suction.

Claim 57 (New): The apparatus of claim 55 wherein said means for controllably supplying irrigation fluid is operatively coupled to control means for controlling said means for applying suction in order that irrigation fluid flow and suction can be oscillated so as not to coincide.

Claim 58 (New): The apparatus of claim 55 wherein said cannula further includes a plurality of nozzles adjacent said distal end for introducing anticoagulant fluid into harvested bone marrow cells, blood, and bone fragments immediately following their harvest.

Claim 59 (New): The apparatus of claim 55 further comprising a collection chamber in fluid communication with said internal passage for receiving and collecting the harvested bone marrow cells, blood, and bone fragments.

Claim 60 (New): The apparatus of claim 55 further comprising a sheath disposed co-axially about a portion of said cannula for providing and maintaining a single percutaneous puncture site.

Claim 61 (New): The apparatus of claim 55 further comprising a rotatable shaft disposed co-axially within said internal passage in said cannula, said shaft having a distal end with a cutting bit for cutting and disrupting bone tissue while preserving necessary viability among harvested marrow cells, said cutting bit projecting through said opening in said cannula.

Claim 62 (New): The apparatus of claim 61 further comprising means for rotating said shaft and said cutting bit.

Claim 63 (New): The apparatus of claim 62 further comprising control means for controlling said means for rotating said shaft.

Claim 64 (New): The apparatus of claim 61 wherein said cannula includes a radially extending end wall that closes a portion of said opening at said distal end of said cannula, said end wall having an axially extending passage through which said shaft projects.

Claim 65 (New): The apparatus of claim 64 wherein said cannula includes a plurality of circumferentially spaced radially extending apertures through which bone marrow cells, blood, and bone fragments disrupted from the bone tissue are aspirated by said means for applying suction.

Claim 66 (New): The apparatus of claim 55 wherein said cannula includes a plurality of circumferentially spaced radially extending apertures through which bone marrow cells, blood, and bone fragments disrupted from the bone tissue are aspirated by said means for applying suction.

Claim 67 (New): The apparatus of claim 55 wherein said opening at said distal end of said cannula extends in the radial direction through said inner surface of said cannula.

Claim 68 (New): The apparatus of claim 67 wherein said distal end of said cannula includes a plurality of third nozzles adjacent said radial opening for introducing an anticoagulant fluid into harvested bone marrow cells, blood, and bone fragments.

Claim 69 (New): The apparatus of claim 67 further comprising a rotatable shaft disposed coaxially with said internal passage in said cannula, said shaft having a distal end with a cutting bit for cutting and disrupting bone tissue while preserving necessary viability among harvested marrow cells, said cutting bit being disposed within said radial opening in said cannula.

Claim 70 (New): The apparatus of claim 69 wherein said cannula includes a radially extending wall that closes off a portion of said internal passage at said distal end of said cannula, said end wall having an axially extending passage through which said shaft projects.

Claim 71 (New): The apparatus of claim 70 wherein said cannula includes a plurality of circumferentially spaced radially extending apertures through which bone marrow cells, blood, and bone fragments disrupted from the bone tissue are aspirated by said means for applying suction.